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MEMORANDUM

SUBJECT: Draft Reports Relating to Proposed Sunnyside Mine Closure

FROM: Paul S. Osborne
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TO: J. David Holm, Director
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and

Rob Walline, Chief
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As requested, I have reviewed the preliminary reports by Simon Hydrosearch relating to the proposed closure of the Sunnyside Mine. Generally, I am surprised that a Company would submit such poor reports in support of a proposal of this magnitude. The reports contain a great deal of anecdotal information and do not contain the level of information on site geologic and hydrologic conditions, mine workings, year round water quality data for potentially affected mines and springs, etc. Based on my review, I believe there is a large potential for flow out of the plugged mine into nearby mines, especially the Mogul Mine, through a combination of open workings and the vein and fractures in the area. I would anticipate significant flow of bad quality water. I have numerous questions and comments as a result of my review. The following two sections summarize these questions.

Preliminary Characterization of the Hydrology and Water Chemistry of the Sunnyside Mine and Vicinity

1. Page 9, Last Paragraph

The report indicates that pyrite in propylitized rocks makes up between 0.1 and 2.0 percent of the rock volume. This is based on a general reference rather than site specific knowledge. It should be noted that a pyrite content in the host rock as high as 5 percent has been reported at

Summitville. If the amount of pyrite in the host volcanics is considered germane to the argument that plugging of the Sunnyside Mine is the best mechanism for closure of the mine, then information on the actual range of pyrite in the ore zone and the host country rock should be provided.

2. Page 12, Third Paragraph

This section provides information on the intergranular permeability of volcanic flows, based on a general reference. There is no actual site specific information on how the host rock at Sunnyside actually compares to the general estimate. Permeability tests on unfractured host rock might provide useful information.

3. Pages 12, 13, 14, and 15

This section discusses the importance of fracture flow in the vicinity of the Sunnyside Mine, especially at depth. The report provided anecdotal information on drilling out of the American tunnel which does demonstrate that some of the veins have significant permeability. The report does not, however, provide the necessary level of detail on the known fracture systems and their present relationship to the mine workings. In my opinion, a detailed analysis of the fracture systems and the mine working (which would include all of the potentially affected mines, such as the Mogul) is needed to evaluate the feasibility of plugging the Sunnyside and associated ground water monitoring that would be needed if plugging was approved. There is a large body of published and perhaps unpublished information on the fracture systems and mine workings in this area. This information should be reviewed and summarized as part of the process for demonstrating the viability of mine plugging.

4. Page 17, Last Paragraph

The usefulness of the estimates of the storage coefficient which are provided is unclear. What is the planned use of the estimates? Estimates of specific storage of the mine workings and the fractures in the mine vicinity would be more useful.

5. Page 18, Last Paragraph

This paragraph is unclear. Is there factual information to support the statement such as a sulfide/oxide ore contact?

6. Page 21, Second Paragraph

A map showing the seep locations is needed. How many seeps and springs are located in both Cement Creek and Eureka Gulch? Data on the actual flow (and associated quality) out of the Silver Lodge Mine and the Big Colorado Mine is not provided. This information is essential for a credible evaluation of the proposal.

7. Page 22, First Paragraph

This paragraph indicates that prior to mining the ground water would have contained an anomalous metal content because of the oxidation of sulfides along fractures. I seriously question this premise. This section raises several questions. What is the source of oxygen oxidation if the fracture systems are full (as they would be in premining conditions)? The extensive limonitic staining mentioned would be related to flow in and out of the upper portion of highly fractured mineralized zones. Is there unstated evidence to support an oxidation mechanism for deeper fracture flow? Although some of the surface fractures in sulfide rich areas fill and drain in response to precipitation events, most of the fracture systems would have been full of water most of the time. This would limit the oxidation of sulfides in contact with water in those fractures. Although the oxidation of sulfides connected to the drainable fractures would affect surface water quality, I question how significantly this would have affected deeper ground water.

8. Page 22, Second Paragraph

What is the basis of the statement that ground water from Fault #1 and Fault #2 has traversed a greater distance from the recharge area than the other faults? These faults could have intersected zones containing more mineralization. Information on the flow out of each of the measured zones should be provided to give a picture of the actual load which is a more meaningful criteria.

9. Page 25, Third Paragraph

Information on the flow from the bog near the Mogul Mine and on the flow out of the mine should be included to give a clearer picture of what is going on at the mine. The actual water quality at both points should also be provided.

10. Page 30, Second and Third Paragraphs

The data to support these statements are very weak. The conclusions seem to be based on data which is from a low flow period. Information during spring and mid-summer are needed to provide a clearer basis for conclusions.

11. Page 31, Second Paragraph

A map showing the extent of the mine workings is needed. This should include all of the mines which may be connected to the Sunnyside via workings or fractures.

12. Page 32, First and Second Paragraphs

What is the specific yield of the fractured rock mass? It would be helpful for the purpose of estimating mine fill-up to have some general estimate of the volume of the mine voids (range).

13. Page 33, Second Paragraph

Information on the water quality of water from the mentioned "valved" drill holes and on water flowing in that portion of the tunnel should be provided. This could provide relevant information on the nature of water quality changes within the apparently confined rock mass versus that for water moving into the tunnel's oxygenated environment.

14. Page 34, Second Paragraph

What is the discharge rate of the various tunnels during spring runoff? Information on the high flow range is needed to adequately evaluate any tunnel plugging proposal.

15. Page 43, Second Paragraph

This section references data showing that most of the metal loading enters the American Tunnel down gradient of the SJCMY property line, near the fracture zone at the steel sets. An unaddressed question is: where does the water exiting from the "steel sets" fracture originate? Given the evidence that there are fractures carrying significant flows above the tunnel, the flow entering the tunnel at the "steel sets" could originate in the Sunnyside mine mineral zone and move laterally via fractures until it reaches the "steel set" fracture. Although the report implies that the "steel Set" fracture is vertical, it may, in fact dip sufficiently to originate within the Sunnyside mineralized zone.

Evaluation of Hydraulic and Hydrochemical Aspects of Proposed Bulkhead - Sunnyside Mine

1. Page 14, First Paragraph

   What is the basis of the assumption that rock in the mine vicinity has an average of 1% pyrite? Is the amount of pyrite relevant given the information that ground water flow is believed to be entirely within fracture?

2. Page 16

   This section should indicate whether there are any ore zones at depth. If so, do these zones have major water flow through them? Figure 6 should be labeled to identify the major veins depicted on the figure.

3. Page 18

   This report and the hydrology report suffers from the absence of a map and cross sections showing both tunnels and the mine workings. The fact that the water was 50 feet below the F level in 1959 means nothing without some good figures. Additionally, it is not clear how the authors determined that the 1959 static water level was deep enough that minor joints would be closed. The basis for such a claim at this location is unverified.

4. Page 22

   It is proposed to place a bulkhead in the American Tunnel near the underground property line with the Gold King property. The report on hydrology indicates this will intercept all water which originates on the SGC property. Given the nature of fracture flow, the certainty of such a statement is questionable. Water could very well originate on the SGC property and enter the tunnel at some distance beyond the property line.

5. Page 24, Second Paragraph

   This section refers to on-going reclamation work in the Sunnyside Basin which may reduce mine inflow. The nature of this work is not described.

6. Page 24, Second and Third Paragraphs

   The report indicates that the water table may stabilize at 11,500 feet (provided that inflow from Lake Emma is stopped, which appears questionable). The report neglects, however,

to state where the lower American Tunnel bulkhead will be set. Based on the elevation of the portal (10,617 feet) the bulkhead could be around 10,750 feet. Thus, there will be 750 to 1,750 feet of head on the single bulkhead. It seems very unlikely, based on the limited information available on the condition of the ground underlying the Sunnyside Basin, that SGC will be successful in eliminating inflow from the Lake Emma area. This almost guarantees that the head on the plug will be much greater than 750 feet.

7. Page 24, Third Paragraph

The report discusses placement of three additional plugs to prevent movement of fluids via flooded working area of the Terry Tunnel or into the Mogul Mine. There is no discussion regarding potential movement into the Gold King properties via fractures or into the Mogul Mine via fractures. Shutting off flow along the Breneman Vein using two plugs may be a tall order. These reports contain insufficient information which would allow me to conclude that significant flow into adjacent mines via vein or fractured structures will be eliminated. A map showing all of the properties and the surface expression of all major faults and veins is needed.

8. Pages 31 and 32

I question the interpretation of the borehole discharge test results which are presented in this section. The straight line nature of the test results for Boreholes 709 and 781 indicate that flow is related to a single fracture system and not a fractured rock mass system. Thus, the resulting hydraulic conductivity values are suspect. A more appropriate method for developing velocity information would be to use a Hele-Shaw Parallel Plate Flow Model. This would result in a much higher conductivity value.

9. Section 8.0

This section attempts to calculate the approximate time for flow out of the mine to begin impacting the various streams in the area. I have doubts as to the validity of the various assumptions used to determine the flow time. The authors assumed that the borehole test data represents highly fractured media. I question this assumption. The data appears to represent flow through a limited fracture system. This is supported by the information indicating that boreholes were drilled into fractures overlying the American Tunnel level which had significant pressure heads. This would indicate that flow velocities in fractures connected to the various mine workings could be much higher than presently assumed.

10. Page 60, Section 9.2

The basis for the validity of the reference water is not well explained. It is not clear that the water moving out of the flooded mine workings will have much contact with the rock mass itself. Movement will occur largely through fractures which will have limited buffering capability. The quality of water moving out of the as yet unflooded mine zones is an unknown factor that does not appear to have been adequately dealt with by the model. In fact, the simulated Terry Tunnel water appears to be more representative of the water which will ultimately move out of the upper ore zone into the fracture system. An important issue which has not been addressed is the certainty that the upper mine workings will never be completely flooded. Thus, acid mine water and oxygen will continue to enter the system through the top.